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UNITED STATES DEPARTMENT OF AGRICULTURE
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MACHINE FOR PICKING UP FILLED GRAPE BOXES^{1/}

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Experiments were conducted in Michigan in 1961 to investigate the possibility of constructing a machine to pick up filled grape boxes. An experimental machine was constructed in 1962 and successfully field tested in several commercial plantings that year (Fig. 1).

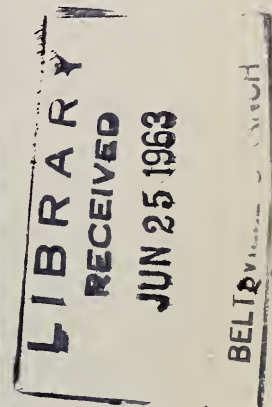


Figure 1. Overall operation shows flow path of boxes during pickup cycle. Note that the man loading need not stoop to remove boxes from holding platforms.

In 1962, 286,250 tons of Concord grapes were produced in six States in the United States. Concord grapes are commonly handled in boxes or trays that hold from 32 to 42 pounds. Therefore, 15 million containers were picked up by hand in these States and moved out of vineyards on trailers or wagons. Grapes are harvested late in the season and it is difficult to find laborers to handle the crop (Fig. 2).

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- ^{1/} Based on cooperative research of Fruit and Vegetable Harvesting Investigations, Agricultural Engineering Research Division, Agricultural Research Service, U.S. Department of Agriculture, and Departments of Horticulture and Agricultural Engineering, Michigan State University, East Lansing, Mich.
- ^{2/} Agricultural Engineers, Agricultural Engineering Research Division, Agricultural Research Service, U.S. Department of Agriculture.



Figure 2. Bending and stooping to pick up filled boxes from the ground is hard work.

Machine Design and Construction

The two major components of the experimental machine are a lifting device and an elevating conveyor. The lifting device (fig. 3) picks up the boxes or trays and moves them onto the elevating conveyor (fig. 4) which, in turn, moves them to a holding platform. The unit was mounted on an early model tricycle-type tractor.

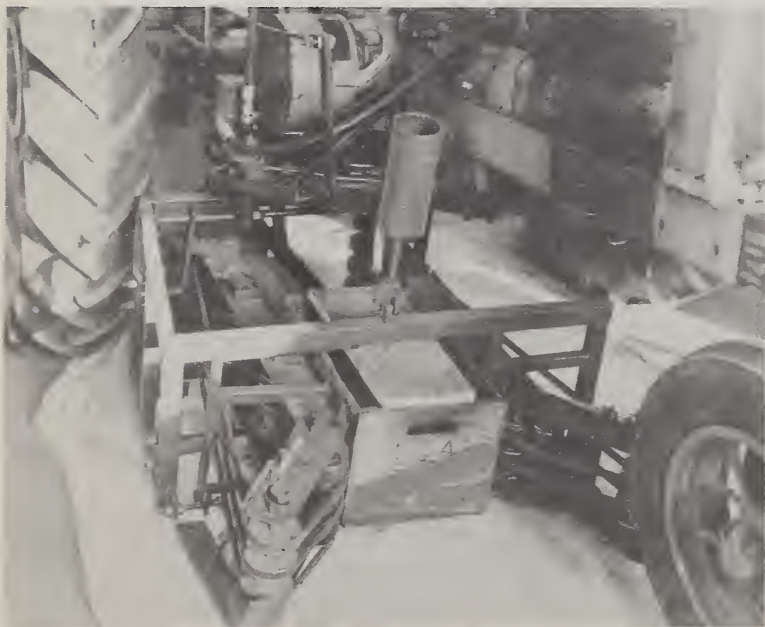


Figure 3. Lifting device exerts pressure on sides of box sufficient to lift it off the ground.

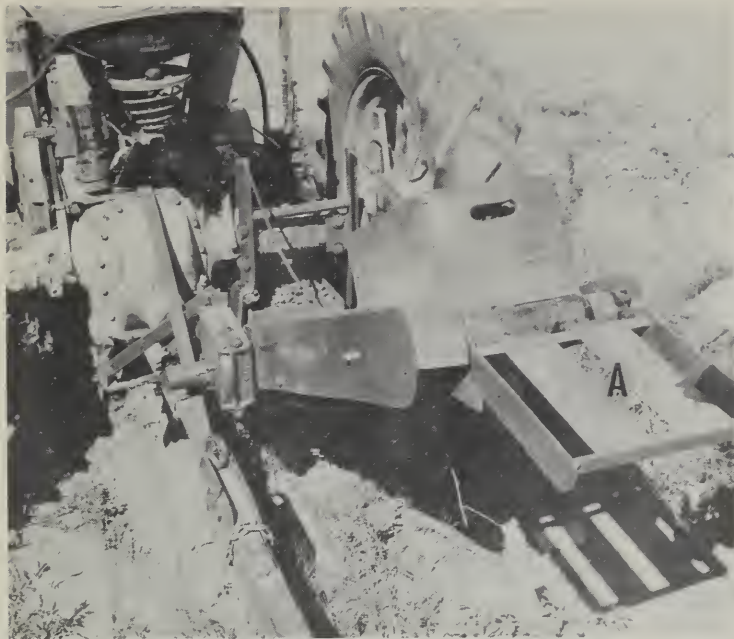


Figure 4. Elevating conveyor moves boxes under rear axle and up to Platform A.

The lifting device consists of three pairs of V-belts arranged so that the moving belts press against the sides of the box (Figs. 3 and 5). The plane in which the belts move is inclined slightly upward from front to back. Spring pressure is applied to the assemblies that hold the belts against the sides of the boxes in such a way that, as the boxes enter the lifting device, they are carried up and back to the place where they move onto the elevating conveyor (Fig. 2). The springs exerting the pressure have a spring constant small enough to allow up to 1-inch variation in box width without adversely affecting the lifting action or the box.

The lifting belts converge from the forward end at an angle of about 30° from each side to help guide the boxes into the machine. The machine might be simplified by replacing the converging belt section with guide rods.

A rubberized fabric elevating conveyor belt raises the boxes to a platform about two feet above the wagon or trailer bed. From this point a man can remove them without stooping. The platform also acts as a temporary holding device.

The tractor frame supports the lifting device and conveyor. Positioning the lifting device just back of and to the right of the tricycle front wheels of the tractor makes it possible to pick up the boxes without interfering with the normal operation of the tractor (Fig. 3). The conveyor receives the boxes at the rear of the lifting device, moves them back under the rear axle, and then raises them up to the platform.

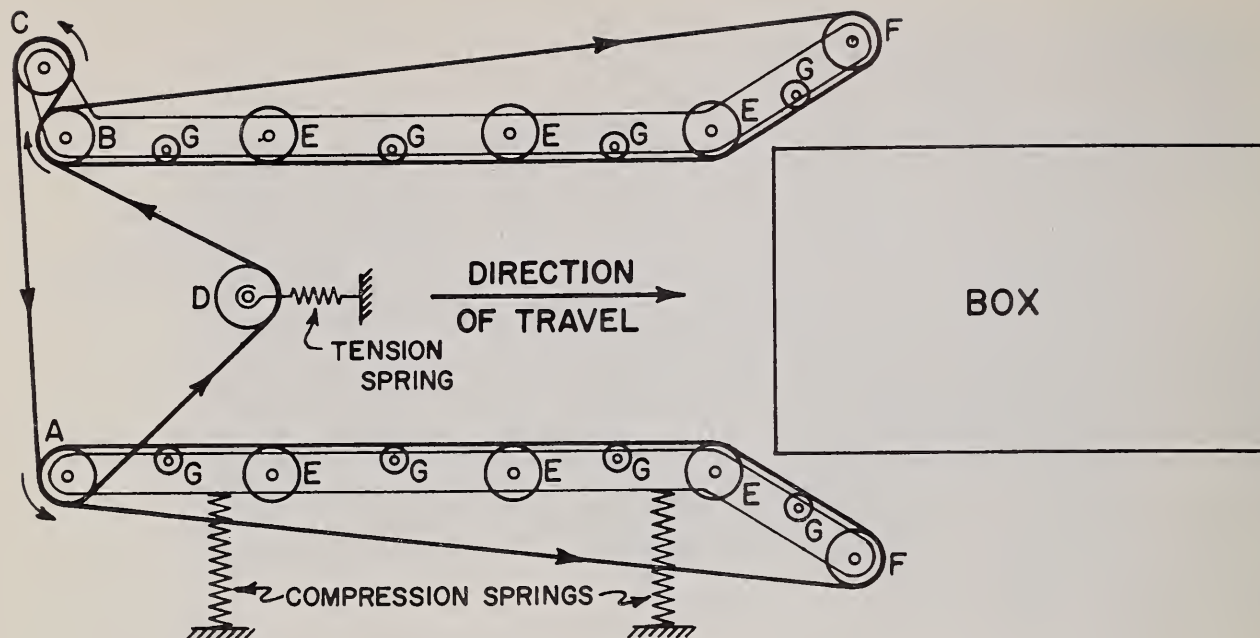


Figure 5. Top view drawing of lifting device.

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| <p>A. Right side V-belt drive shaft driven directly by a low speed, high torque hydraulic motor. Motor, sprocket and sheave are attached to a common shaft.</p> <p>B. Left side V-belt drive shaft. Sprocket and sheave have common shaft.</p> <p>C. Idler sprocket for reversing the direction of rotation of B.</p> | <p>D. Spring loaded chain tension idler sprocket.</p> <p>E. Idler sheaves for forming parallel box contact belt surfaces.</p> <p>F. Idler sheaves for forming converging box contact belt surfaces.</p> <p>G. Idler rollers that supply additional backing to V-belt when in contact with a box.</p> |
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The right and left halves of the lifting device are attached to a common frame. The right half is spring loaded and, within limits, movable relative to the left half.

Power is transmitted to the lifting mechanisms through a low-speed, high-torque hydraulic motor directly connected to the right hand V-belt carrier. The elevating conveyor is driven from the tractor power takeoff through a 3 to 1 right angle gear reducer. The tractor used for the trials did not have its own hydraulic system, so it was necessary to mount an 11 gallon per minute pump on the tractor.

Machine Operation

The filled boxes must first be placed by the pickers in a line between the rows, slightly to the right of the path of the tricycle front wheel travel. The line must be reasonably straight, but the alignment of individual boxes can be off as much as 15° in either direction without affecting the operation of the machine (Fig. 6).



Figure 6. Boxes must be positioned in row prior to machine pickup. Alignment may vary up to 15° in either direction.

A pickup device could be designed and mounted on a tractor to collect boxes from the center of the space between the rows. This would simplify operations by allowing the pickup machine to travel down the rows in either direction.

The pickup operation requires a two-man crew. One man drives the tractor, while the other one stands on the wagon or trailer and stacks the boxes (Fig. 1).

ADVANTAGES

Time and labor studies on both the conventional^{3/} and the machine methods of picking up boxes were conducted in the field. Table 1 summarizes the results of these studies. The grape yield was approximately five tons per acre. The wage rate used in computing labor costs was \$1.25 per hour.

A large percentage of the grapes are produced by growers with small acreages. A crew of two, made up of a father and son or a husband and wife usually handle the harvesting operations on these small vineyards. Thus, no wages would be paid to hired help. The savings in time and labor, however, would be significant even in small vineyards.

^{3/} Hedden, S. L.; Levin, J. H.; and Gaston, H. P. 1960. A Progress Report on Harvesting and Handling Concord Grapes. ARS 42-42.

Table 1. Boxes of grapes handled and cost of labor, by hand and machine methods.

Method	Crew	Boxes handled	Time	Boxes per minute	Cost per acre	Cost per ton
	<u>Number</u>	<u>Number</u>	<u>Minute</u>	<u>Number</u>	<u>Dollar</u>	<u>Dollar</u>
Hand	2	36	8	4.5	2.65	.53
Machine	2	119	17 1/2	6.8	1.75	.35
Savings by machine method					.90	.17

Width adjustments in the box pickup machine could be made to adapt it to a variety of rectangular containers. Thus, this experimental machine might be used with other fruit and vegetable crops such as apples, peaches, pears, onions, carrots, and potatoes. Also, the pickup unit should be easily adaptable for use on other types of tractors.

Summary

A study of present methods for handling grape boxes showed the need for an easier, less expensive method of picking up filled boxes. In 1961, the feasibility of building a pickup machine was investigated, and in 1962 an experimental machine was constructed and successfully field tested. A commercial machine of this type was not available in 1962.

The basic design and construction of the experimental machine is relatively simple. It consists of a lifting device that exerts pressure on the sides of the boxes sufficient to raise the boxes onto an elevating conveyor. The conveyor then moves the boxes back under the rear axle of the tractor and raises them to a holding platform above the wagon or trailer bed.

Operation of the machine requires a two-man crew, with one man driving the tractor and the other man stacking the boxes.

Preliminary tests showed that the machine would save time and money.

Acknowledgments

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SPECIFICATIONS

Dimensions of boxes used (inches):

	<u>Length</u>	<u>Width</u>	<u>Height</u>
Beer boxes ^{1/}	18	12	10
Welch trays	22	10.5	7

Approximate power requirements:

Lifting device	1 hp.
Conveyor	1/3 hp.
Tractor (pulling loaded trailer)	2 plow size

1/ Over half of the containers used for handling Concord grapes are wooden containers originally used for handling beer.

